STIRLING CYCLE MACHINE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a Continuation of U.S. patent application Ser. No. 15/649,343 filed Sep. 1, 2017 and entitled Stirling Cycle Machine, now U.S. Publication No. US-2018-0179988-A1, published Jun. 28, 2018 (Attorney Docket No. 203), which is a Continuation of U.S. patent application Ser. No. 13/932,276 filed Jul. 1, 2013 and entitled Stirling Cycle Machine, now U.S. Pat. No. 9,752,532, issued Sep. 5, 2017 (Attorney Docket No. 189), which is a Continuation of U.S. patent application Ser. No. 12/105,854, filed Apr. 18, 2008 and entitled Stirling Cycle Machine, now U.S. Pat. No. 8,474,256, issued Jul. 2, 2013 (Attorney Docket No. 170), which claims priority from U.S. Provisional Patent Application No. 60/925,818, filed Apr. 23, 2007 and entitled Four Cylinder Stirling Engine (Attorney Docket No. DEKA-012XX); and U.S. Provisional Patent Application No. 60/925,814, filed Apr. 23, 2007 and entitled Rocking Beam Drive (Attorney Docket No. DEKA-013XX), all of which are hereby incorporated herein by reference in their entireties.

TECHNICAL FIELD

[0002] The present invention relates to machines and more particularly, to a Stirling cycle machine and components thereof.

BACKGROUND INFORMATION

[0003] Many machines, such as internal combustion engines, external combustion engines, compressors, and other reciprocating machines, employ an arrangement of pistons and drive mechanisms to convert the linear motion of a reciprocating piston to rotary motion. In most applications, the pistons are housed in a cylinder. A common problem encountered with such machines is that of friction generated by a sliding piston resulting from misalignment of the piston in the cylinder and lateral forces exerted on the piston by linkage of the piston to a rotating crankshaft. These increased side loads increase engine noise, increase piston wear, and decrease the efficiency and life of the engine. Additionally, because of the side loads, the drive requires more power to overcome these frictional forces, thus reducing the efficiency of the machine.

[0004] Improvements have been made on drive mechanisms in an attempt to reduce these side loads, however, many of the improvements have resulted in heavier and bulkier machines.

[0005] Accordingly, there is a need for practical machines with minimal side loads on pistons.

SUMMARY

[0006] In accordance with one aspect of the present invention, a rocking beam drive mechanism for a machine is disclosed. The drive mechanism includes a rocking beam having a rocker pivot, at least one cylinder and at least one piston. The piston is housed within a respective cylinder. The piston is capable of substantially linearly reciprocating within the respective cylinder. Also, the drive mechanism includes at least one coupling assembly having a proximal end and a distal end. The proximal end is connected to the piston and the distal end is connected to the rocking beam by an end pivot. The linear motion of the piston is converted to rotary motion of the rocking beam.

[0007] Some embodiments of this aspect of the present invention include one or more of the following: where the rocking beam is coupled to a crankshaft by way of a connecting rod. In this embodiment, the rotary motion of the rocking beam is transferred to the crankshaft. Also, where the cylinder may further include a closed end and an open end. The open end further includes a linear bearing connected to the cylinder. The linear bearing includes an opening to accommodate the coupling assembly. Also, where the coupling assembly further includes a piston rod and a link rod. The piston rod and link rod are coupled together by a coupling means. The coupling means is located beneath the linear bearing. Also, where the drive mechanism also includes a seal, where the seal is sealably connected to the piston rod. Also, where the seal is a rolling diaphragm. Also, in some embodiments, the coupling means is a flexible joint. In some embodiments, the coupling means is a roller bearing. In some embodiments, the coupling means is a hinge. In some embodiments, the coupling means is a flexure. In some embodiments, the coupling means is a journal bearing joint.

[0008] In accordance with another aspect of the present invention, a Stirling cycle machine is disclosed. The machine includes at least one rocking drive mechanism where the rocking drive mechanism includes: a rocking beam having a rocker pivot, at least one cylinder and at least one piston. The piston is housed within a respective cylinder. The piston is capable of substantially linearly reciprocating within the respective cylinder. Also, the drive mechanism includes at least one coupling assembly having a proximal end and a distal end. The proximal end is connected to the piston and the distal end is connected to the rocking beam by an end pivot. The linear motion of the piston is converted to rotary motion of the rocking beam. Also, a crankcase housing the rocking beam and housing a first portion of the coupling assembly is included. A crankshaft coupled to the rocking beam by way of a connecting rod is also included. The rotary motion of the rocking beam is transferred to the crankshaft. The machine also includes a working space housing the at least one cylinder, the at least one piston and a second portion of the coupling assembly. A seal is included for sealing the workspace from the crankcase.

[0009] Some embodiments of this aspect of the present invention include one or more of the following: where the seal is a rolling diaphragm. Also, the cylinder may further include a closed end and an open end. The open end further includes a linear bearing connected to the cylinder. The linear bearing includes an opening to accommodate the coupling assembly. Also, where the coupling assembly further includes a piston rod and a link rod. The piston rod and link rod are coupled together by a coupling means. The coupling means may be located beneath the linear bearing. Also, the machine may also include a lubricating fluid pump in the crankcase. In some embodiments, the lubricating fluid pump is a mechanical lubricating fluid pump driven by a pump drive assembly, the pump drive assembly being connected to and driven by the crankshaft. In some embodiments, the lubricating fluid pump is an electric lubricating fluid pump. The machine may also include a motor connected to the crankshaft. The machine may also include a generator connected to the crankshaft.

[0010] In accordance with another aspect of the present invention, a Stirling cycle machine is disclosed. The